General

Guideline Title

ACR Appropriateness Criteria® urinary tract infection—child.

Bibliographic Source(s)

Karmazyn BK, Alazraki AL, Anupindi SA, Dempsey ME, Dillman JR, Dorman SR, Garber MD, Moore SG, Peters CA, Rice HE, Rigsby CK, Safdar NM, Simoneaux SF, Trout AT, Westra SJ, Wootton-Gorges SL, Coley BD, Expert Panel on Pediatric Imaging. ACR Appropriateness CriteriaÂ® urinary tract infectionâ€“child. Reston (VA): American College of Radiology (ACR); 2016. 12 p. [92 references]

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Karmazyn B, Coley BD, Binkovitz LA, Dempsey-Robertson ME, Dillman JR, Dory CE, Garber M, Hayes LL, Keller MS, Meyer JS, Milla SS, Paidas C, Raske ME, Rigsby CK, Strouse PJ, Wootton-Gorges SL, Expert Panel on Pediatric Imaging. ACR Appropriateness Criteria® urinary tract infection - child. [online publication]. Reston (VA): American College of Radiology (ACR); 2012. 8 p. [91 references]

This guideline meets NGC's 2013 (revised) inclusion criteria.

Recommendations

Major Recommendations

ACR Appropriateness Criteria®

Clinical Condition: Urinary Tract Infection—Child

Variant 1: Age <2 months, first febrile urinary tract infection.

Radiologic Procedure	Rating	Comments	RRL*
US kidneys and bladder	9		O
X-ray voiding cystourethrography	6	Consider this procedure in boys and in the presence of sonographic abnormality.	☢☢
Tc-99m pertechnetate radionuclide cystography	5	Consider this procedure in girls.	☢
Tc-99m DMSA cortical scintigraphy	3	This procedure is not first-line; usually used 4 to 6 months after UTI to detect scarring.	☢☢☢

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

***Relative Radiation Level**

Radiologic Procedure	Rating	Comments	RRL*
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Age >2 months and ≤6 years, first febrile urinary tract infection with good response to treatment.

Radiologic Procedure	Rating	Comments	RRL*
US kidneys and bladder	7	This procedure has a low yield, especially if US in the third trimester is normal.	O
X-ray voiding cystourethrography	4		☢☢
Tc-99m pertechnetate radionuclide cystography	4		☢
Tc-99m DMSA renal cortical scintigraphy	3		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: Age >6 years, first febrile urinary tract infection with good response to treatment.

Radiologic Procedure	Rating	Comments	RRL*
US kidneys and bladder	5	This procedure may be appropriate but there was disagreement among panel members on the appropriateness rating as defined by the panel's median rating.	O
X-ray voiding cystourethrography	3		☢☢
Tc-99m pertechnetate radionuclide cystography	3		☢
Tc-99m DMSA renal cortical scintigraphy	2		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 4: Child. Atypical (poor response to antibiotics within 48 hours, sepsis, poor urine stream, raised creatinine, or non-*E. coli* UTI) or recurrent febrile urinary tract infection.

Radiologic Procedure	Rating	Comments	RRL*
US kidneys and bladder	9	This is a complementary procedure.	O
X-ray voiding cystourethrography	7	This is a complementary procedure.	☢☢
Tc-99m pertechnetate radionuclide cystography	7	This procedure is an alternative for cystourethrography. Consider it in girls.	☢
Tc-99m DMSA renal cortical scintigraphy	6	This procedure could be used 4 to 6 months after UTI to detect scarring.	☢☢☢
CT abdomen and pelvis with IV contrast	4	This procedure is indicated in patients with suspected abscess.	☢☢☢☢
CT abdomen and pelvis without IV	2	This procedure [illegible] stone	☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Radiologic Procedure	Rating	Comments	RRL*
contrast		disease is suspected.	
CT abdomen and pelvis without and with IV contrast	1		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Summary of Literature Review

Introduction/Background

Urinary tract infection (UTI) is the most frequent serious bacterial infection during childhood, affecting approximately 2% of boys and 8% of girls by the age of 7 years. UTI is defined by the presence of bacteria within the urine and is confirmed by a urine culture of at least 5 x 10^4 colony-forming units (cfu)/mL of the same bacterial species in a catheterized specimen or 10^5 cfu/mL in a voided specimen. Approximately 75% of UTIs occur in the first 2 years of life. The first peak of UTI is in the first year of life, and the second peak of UTI occurs between the ages of 2 to 4 years during toilet training. After the age of 6 years, UTIs are infrequent and often associated with dysfunctional elimination.

Cystitis is a UTI limited to the bladder. Cystitis typically presents with localizing symptoms of frequency, urgency, and dysuria. Acute pyelonephritis is infection of the kidneys. Pyelonephritis typically presents with systemic symptoms such as high fever, malaise, vomiting, abdominal or flank pain, and tenderness. Pyelonephritis can cause renal scarring, which is the most severe long-term sequela of UTI that can lead to hypertension and chronic renal failure. With the increased use of prenatal ultrasound (US), it was realized that many of the scars that were attributed to pyelonephritis actually occur in utero and represent renal dysplasia. Contrary to earlier studies suggesting that renal scarring secondary to pyelonephritis is the most common cause of chronic renal disease in children, it is now evident that the long-term risk is low. The role of imaging is to guide treatment by identifying patients who are at high risk to develop recurrent UTIs or renal scarring. However, identification of children at risk is valuable only if there is effective treatment. Current management strategy to prevent UTIs and renal scarring is based on prophylactic antibiotics and selective surgical correction of vesicoureteral reflux (VUR). Prospective studies failed to demonstrate significant decrease in renal scarring in patients with febrile UTI who were treated with prophylactic antibiotics, and surgical correction of VUR was not found to improve outcome. Thus the effectiveness of current management of UTIs is put into question.

Pyelonephritis is diagnosed in children based on the presence of pyuria and/or bacteriuria, fever, flank pain, or tenderness. Between 50% and 64% of children who have a febrile UTI are found to have defects on renal cortical scintigraphy (RCS) indicating acute pyelonephritis. The relationship between childhood UTIs, VUR, and renal scarring is complex and not completely understood. Children with VUR are at an increased risk for pyelonephritis and parenchymal scarring, but pyelonephritis and renal scarring commonly occur without VUR. The incidence of acute pyelonephritis in the absence of documented VUR is much too high to be explained only by intermittent VUR. Previous episodes of pyelonephritis or VUR increase the risk for recurrent pyelonephritis. Absence of fever does not exclude development of pyelonephritis.

Cystitis in the absence of pyelonephritis is usually not associated with long-term sequelae. The incidence of scarring in children following pyelonephritis varies widely in the literature. A systemic review of the literature showed that 15% (95% CI, 11%-18%) of the children had evidence of renal scarring after the first episode of UTI. Contrary to common belief, renal scarring after pyelonephritis does not decrease in older children.

Reports from the 1960s and 1970s showed that scarring secondary to pyelonephritis is the etiology for 50% of hypertension and 30% of end-stage renal disease (ESRD) cases in children. Many of the cases that were attributed to scarring from pyelonephritis actually represented congenital hypoplastic or dysplastic kidneys. Scarring accounts for 5% of children with hypertension. Retrospective studies demonstrated that mainly children with bilateral renal scarring are at risk for renal insufficiency. According to the North American Pediatric Renal Trials and Collaborative Studies 2011 report, reflux nephropathy accounted for 3.5% of ESRD cases. Worldwide, reflux nephropathy accounted for 7% to 17% of ESRD cases.

The main purposes of treating UTIs are to cure acute pyelonephritis and cystitis and to prevent recurrent UTIs and renal scarring. Acute UTIs are typically treated with oral antibiotics. Prophylactic long-term oral antibiotics may decrease the incidence of recurrent UTIs and renal scarring. However, the benefit is small and should be weighed against the risk of microbial resistance.

Prospective studies in children between the ages of 2 months and 6 years with UTIs were done to evaluate the effect of therapy. There is limited medical-based evidence to support routine imaging of uncomplicated UTIs, and optimal imaging is controversial. Currently there are 2 main methods for evaluating children with UTIs: the bottom-up approach, which focuses on detection of VUR, and the top-down approach, which focuses on the diagnosis of acute pyelonephritis and renal scarring.

Until recently it was not clear if children with VUR benefit from treatment. A prospective Swedish reflux trial randomized treatment (antibiotic prophylaxis, endoscopic correction of reflux, or surveillance) in 203 children with grade III or IV reflux. There was a significantly lower rate of recurrent febrile UTIs in girls receiving antibiotics and endoscopic treatment. No scar developed in children treated with antibiotics. However, the number of patients in this study was small. The Randomized Intervention for Children with Vesicoureteral Reflux (RIVUR) trial in 607 children aged 2 months to 6 years with VUR grades of I to IV demonstrated decreased recurrent UTIs in half of the patients (n = 305) who received prophylactic antibiotics as compared to these who received placebo (n = 302). Incidence of recurrent UTIs increased with increased grade of VUR (14.3% in grades I-II and 22.9% in grades III-IV). The benefits of prophylactic antibiotics increased with the presence of fever (80%) and bowel and bladder dysfunction (60%). There was no significant change in the development of new renal scarring (about 8%).

Surgery—open, laparoscopic, or endoscopic (injection of a bulking agent)—is usually reserved for high-grade VUR, recurrent UTI despite antibiotic prophylaxis, and noncompliance with prophylactic antibiotics.

Other nonsurgical treatment options are targeted to children with a variety of bladder functional abnormalities, including behavioral modification, biofeedback relaxation of the pelvic floor, and treatment of constipation.

UTI in a neonate requires special consideration. The prevalence of UTI in term neonates varies from 0.1% to 1%, with a male predominance in the first 2 months of life. The presentation of UTI is generally nonspecific, with symptoms similar to those seen in neonatal sepsis, and not all children will have fever. Concomitant bacteremia with UTI is common and was observed in the range of 4% to 36.4%. Neonates with UTI have a high incidence of urinary anomalies; the most common is VUR.

Overview of Imaging Modalities

Ultrasonography

Renal ultrasound (US) is a noninvasive imaging method that avoids the risk of ionizing radiation and is readily available. It can detect urinary tract anomalies such as hydronephrosis, duplex renal system, hydroureter, and ureterocele. In older children, postvoid evaluation of bladder volume could be useful to assess for functional bladder abnormalities and retention syndrome. The main limitation of US is the low sensitivity for detecting VUR and renal scarring.

Renal Cortical Scintigraphy

RCS with techetium-99 metastable (Tc-99m) dimercaptosuccinic acid (DMSA) or Tc-99m glucoheptonate is used for the detection of pyelonephritis. Tc-99m DMSA has higher image quality than Tc-99m glucoheptonate, which makes DMSA a more desirable agent for renal cortical imaging, especially in small infants, in those with poorly functioning kidneys, and when other studies have identified dilated uropathy or high-grade VUR cases. Pinhole imaging or single photon-emission computed tomography (SPECT) should be considered to maximize the sensitivity of RCS without loss of specificity.

The likelihood of dilated VUR in children with normal RCS is low. RCS is the gold-standard study for evaluation of renal scarring. It is used as an important outcome finding in studying various treatment options for children with UTIs.

X-Ray Voiding Cystourethrography, Nuclear Cystography, and Voiding Ultrasonography

The main role of voiding cystourethrography (VCUG) is to detect VUR. Radionuclide cystography (RNC) has a lower absorbed radiation dose than VCUG, but it does not have the spatial resolution needed to identify anatomic abnormalities of the urethra, bladder, and ureters. Voiding ultrasonography (VUS) is a nonionizing, safe, and accurate method to evaluate for VUR. The bladder is filled with a solution containing microbubbles that appear echogenic by US. This technique has been accepted in several European countries where US contrast agents are approved for this application. Using a first-generation contrast agent, the diagnostic accuracy of VUS as compared to VCUG has ranged from 78% to 96%, with most studies showing accuracy of 90% or above. Some studies suggest that VUS is more sensitive than VCUG in the detection of dilated VUR. Use of a second-generation contrast agent and transperineal approach enables improved evaluation of the bladder and urethra. However, in the United States, US contrast for VUS is not approved by the Food and Drug Administration and can only be used as off-label. There is not yet any published experience with VUS in the United States.

Computed Tomography

Postcontrast computed tomography (CT) scan is sensitive in diagnosing pyelonephritis. It has a role in evaluation of renal abscess or unusual complications such as xanthogranulomatous pyelonephritis.

Magnetic Resonance Imaging

Small series demonstrated that magnetic resonance imaging (MRI) has high sensitivity for detecting pyelonephritis, comparable to DMSA scintigraphy. Diffusion MR has comparable sensitivity to contrast-enhanced MRI in the detection of pyelonephritis. There is no role of MRI in predicting the presence of VUR. MRI is not routinely used in the evaluation of children with UTI because of its relatively high cost, low availability, and potential need for sedation in younger patients.

Variant 1: Age <2 Months, First Febrile Urinary Tract Infection

Ultrasonography

In children <2 months there is increased incidence of sepsis and renal anomalies associated with UTIs and increased rate of hospitalization. Therefore, the potential benefit at that age is greater than in older children. However, there is low-quality evidence on the benefit of imaging on outcome. Hydronephrosis is the most frequent abnormality, found in 45% of neonates with UTI. US should be performed even if the intrauterine US was normal. In a study on newborn males with UTI, 8 of 12 children with abnormal US had a normal intrauterine US; 1 patient had a posterior urethral valve and 4 patients had dilated (grades III-IV) VUR. As discussed above, the main limitation of US is in the detection of parenchymal abnormalities and VUR.

X-ray Voiding Cystourethrography and Nuclear Cystography

VCUG has been shown to detect VUR in newborn males even if US is normal. A finding of VUR, especially high-grade VUR, may lead to a change in management. VUR is more commonly detected in boys as compared to girls. In addition, one of the main concerns in boys is missing a case of posterior urethral valve. The UK National Institute for Health and Care Excellence (NICE) guidelines for UTI do not recommend routine VCUG in evaluation of UTI in children younger than 6 months. Others advocate performing routine VCUG studies in all male newborns. In females there is no need for detailed anatomical evaluation of the urethra, and RNC can be performed instead of VCUG as it has lower radiation.

Renal Cortical Scintigraphy

RCS has a limited role in guiding management of newborns with febrile UTI as the main concern in this age is the presence of underlying renal anomalies.

Variant 2: Age >2 Months and ≤6 Years, First Febrile Urinary Tract Infection with Good Response to Treatment

Ultrasonography

Routine US study after the first episode of UTI is suggested by several guidelines. The main benefit of US is for the detection of underlying congenital renal anomalies.

The potential harm of using US as the only imaging for UTI is the poor sensitivity for VUR and parenchymal abnormalities. The sensitivity for detecting VUR and renal scarring is low. There are limited data showing inconsistent results on the sensitivity of US in the detection of dilated VUR. Grayscale US identifies about 25% of acute pyelonephritis and about 40% of chronic parenchymal scarring cases.

In a retrospective study of 2259 children younger than 5 years, sensitivity was related to criteria for the definition of a normal study. With the use of the most relaxed criteria (25% abnormal), US had a sensitivity of 28% (specificity of 77%), and with the most stringent criteria (4% abnormal), US had a sensitivity of 5% (specificity of 97%). Assuming 40% prevalence of VUR and 20% recurrent rate of UTIs in 100 children who have US, up to 11 children will have positive US studies that will be followed by a VCUG study, of which 8 will be positive for VUR. Two years of a prophylactic antibiotic will decrease recurrent UTIs from up to 2 children to 1 child. This means that 1 child will benefit from the US study and an additional 3 children that may benefit from prophylactic antibiotic will not be treated. In addition, with the increased use of prenatal US screening, the yield of detection of unknown renal abnormalities in children with UTIs has decreased.

Few studies with small series of children suggest good correlation between power Doppler and Tc-99m DMSA findings of pyelonephritis. Other studies, however, demonstrated low sensitivity for pyelonephritis and low prediction for development of renal scarring. Therefore, the use of power Doppler as a replacement for RCS cannot be recommended.

Renal Cortical Scintigraphy

RCS, Tc-99m DMSA, and Tc-99m glucoheptonate are sensitive (90%) and specific (95%) tests for detecting pyelonephritis. However, short-term studies have demonstrated that many of these abnormalities resolve over time, irrespective of whether a prophylactic antibiotic was used. This suggests little benefit in using RCS after the first episode of UTI. Persistent parenchymal abnormality in RCS or decreased uptake of tracer associated with loss of contour or cortical thinning are indications of renal scarring. Most recurrent UTIs occur within 3 to 6 months after the first episode of UTI. The NICE guideline suggests a delayed RCS (4 to 6 months) to evaluate for renal scarring in high-risk patients.

RCS, followed by cystourethrography if the RCS suggests pyelonephritis, is the top-down approach. The benefit of this approach is the decrease in the number of cystourethrography studies. There are few deficiencies with the use of RCS as the primary imaging for UTI.

Evidence of acute pyelonephritis is detected by RCS in children with UTIs in about 50% to 80% of cases. This means that RCS will not change the need to perform VCUG in most patients. There is conflicting evidence on the sensitivity of RCS in the detection of VUR. In a randomized controlled study comparing oral versus intravenous antibiotic administration, 308 patients who had Tc-99m DMSA were evaluated. The sensitivity for VUR was 70%, with a specificity of 42%. A meta-analysis study on the use of DMSA in acute UTI yielded a sensitivity and specificity of 79% and 53%, respectively, for dilated hydronephrosis. There was marked statistical heterogeneity between the studies. The authors concluded that acute-phase DMSA renal scanning cannot be recommended as a replacement for VCUG in the evaluation of young children with a first febrile UTI.

There are other limitations of using RCS as the primary imaging for UTI. RCS for children is not readily available and usually takes place in specialized medical centers. Studies are performed 3 to 4 hours after intravenous injection and may require sedation in young children. The estimated effective dose of DMSA is approximately 1 mSv, which is about 100 times more than nuclear cystography and about 10 times more than current low-dose VCUG technique.

X-ray Voiding Cystourethrography and Nuclear Cystography

The main role of VCUG is to detect VUR. Studies that include only children with VUR suggest that this group of patients may benefit more from prophylactic antibiotics. The RIVUR study, which enrolled 607 children 2 months to 6 years old with any grade of VUR, demonstrated that 2 years of prophylactic antibiotics in children with VUR decreased the incidence of recurrent UTIs by half (number needed to treat for 2 years, 8). Patients with high-grade VUR (grades III-IV) are more likely to have recurrent UTIs and scarring and may benefit even more from prophylactic antibiotics. The Swedish study randomly assigned 203 children 12 to 23 months of age with dilated (grade III or IV) VUR and demonstrated benefit only in girls who received either prophylactic antibiotics or endoscopic treatment in decreasing recurrent UTI (number needed to treat for 2 years, 2.5 and 3, respectively). Girls who received antimicrobial prophylaxis had the lowest incidence of renal scarring (number needed to treat for 2 years, 5).

The potential harms of VCUG relate to exposing children that will not benefit from a prophylactic antibiotic to an unpleasant study associated with minimal ionizing radiation and additional costs. In addition, there was no evidence of a decrease in renal scarring with prophylactic antibiotics, and the proportion of *Escherichia coli* isolates that were resistant to trimethoprim-sulfamethoxazole increased (63% in the prophylaxis group and 19% in the placebo group). Minor adverse drug reactions from prophylactic antibiotics were reported in 7% of children in one trial and antibiotics were stopped for suspected adverse reactions in up to 3.5% of the children in other studies.

VUR is detected with equal sensitivity by fluoroscopic contrast VCUG and direct RNC. A second filling of the bladder (cyclic cystography) increases overall detection of VUR and dilated VUR. Cyclic VCUG may be appropriate in children older than 2 years who cannot control voiding and when there is a high suspicion of VUR.

RNC has a lower absorbed radiation dose than VCUG, but it does not have the spatial resolution needed to identify anatomic abnormalities of the urethra, bladder, and ureters. Initial evaluation of VUR in girls and follow-up studies can be done by RNC.

Variant 3: Age >6 Years, First Febrile Urinary Tract Infection with Good Response to Treatment

The incidence of new-onset UTI in children older than 6 years is infrequent and often associated with behavioral abnormalities, dysfunctional elimination syndrome, or, at the teenage period, initiation of sexual intercourse. Girls are affected more often than males. The likelihood of detection of unknown underlying renal anomaly is low. There is no evidence to support any routine imaging in the first UTI in this group of patients.

Variant 4: Atypical (Poor Response to Antibiotics within 48 Hours, Sepsis, Poor Urine Stream, Raised Creatinine, or Non–*E coli* UTI) or Recurrent Febrile Urinary Tract Infection

Ultrasonography

In children with atypical, recurrent, or complicated UTI, the main benefit of US is the detection of underlying abnormalities, stones, or complications such as a renal or perirenal abscess. US has low sensitivity in detection of parenchymal abnormalities or VUR.

Renal Cortical Scintigraphy

RCS may have limited benefit in patients with VUR and atypical, complicated, or recurrent UTIs. Demonstration of renal scarring may suggest increased long-term risk for renal injury from VUR and support endoscopic or surgical antireflux management. RCS may also be helpful in predicting the risk of breakthrough infection and renal damage in children with VUR.

X-ray Voiding Cystourethrography and Nuclear Cystography

The prevalence of VUR increases in children with recurrent UTIs. In a hypothetical cohort of infants after first UTI and recurrent UTI, VUR increases from 35% to 74%, with increased risk of renal scarring with each UTI. A finding of VUR may lead to antibiotic prevention treatment, and a finding of dilated VUR may lead to endoscopic or surgical treatment. As discussed above, nuclear cystography can be used in follow-up studies and as a first study in females.

Computed Tomography

Postcontrast CT scan is sensitive in diagnosing pyelonephritis. However, because of its radiation it should be performed selectively when there is suspicion for complications such as renal abscess or xanthogranulomatous pyelonephritis.

Summary of Recommendations

- Imaging of UTI in children younger than 2 months may need to be more conservative, as neonates with UTI have a higher incidence of renal anomalies and are more likely to be complicated with sepsis. US is usually appropriate and cystourethrography may be appropriate in boys and whenever there are any sonographic abnormalities.
- In children aged >2 months and ≤6 years with a first febrile UTI with good response to treatment, imaging typically does not have a role in guiding management. US is the only imaging that is usually appropriate.
- In children aged >6 years with a first febrile UTI with good response to treatment, there is lower prevalence of VUR and there is usually no need for imaging to guide treatment. The role of US in this age group is controversial.
- In complicated UTIs (not responding well to antibiotics within 48 hours, sepsis, decreased urine stream, raised creatinine, or non–*E coli* UTI) or recurrent UTIs, the child should be imaged with VCUG in addition to US to help select children who may benefit from prophylactic antibiotics or antireflux intervention.

Abbreviations

- CT, computed tomography
- DMSA, dimercaptosuccinic acid
- *E. coli*, *Escherichia coli*
- IV, intravenous
- Tc-99m, technetium-99 metastable
- US, ultrasound
- UTI, urinary tract infection

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."		

Clinical Algorithm(s)

Algorithms were not developed from criteria guidelines.

Scope

Disease/Condition(s)

Urinary tract infection (UTI)

Guideline Category

Diagnosis

Evaluation

Management

Clinical Specialty

Family Practice

Infectious Diseases

Internal Medicine

Nephrology

Nuclear Medicine

Pediatrics

Radiology

Urology

Intended Users

Advanced Practice Nurses

Health Plans

Hospitals

Managed Care Organizations

Physician Assistants

Physicians

Students

Utilization Management

Guideline Objective(s)

To evaluate the appropriateness of imaging procedures in pediatric patients with urinary tract infection

Target Population

Neonates, infants, and children with urinary tract infection (first or recurrent)

Interventions and Practices Considered

1. Ultrasound (US), kidneys and bladder
2. X-ray voiding cystourethrography
3. Technetium-99 metastable (Tc-99m) pertechnetate radionuclide cystography
4. Tc-99m dimercaptosuccinic acid (DMSA) renal cortical scintigraphy
5. Computed tomography (CT), abdomen and pelvis
    - With intravenous (IV) contrast
    - Without IV contrast
    - Without and with IV contrast

Major Outcomes Considered

- Utility of imaging procedures in the diagnosis and management of urinary tract infections (UTIs)
- Sensitivity and specificity of imaging procedures for detecting UTIs
- Incidence of recurrent UTIs
- Incidence of renal scarring
- Incidence of long-term sequelae

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Literature Search Summary

Of the 92 citations in the original bibliography, 70 were retained in the final document. Articles were removed from the original bibliography if they were more than 10 years old and did not contribute to the evidence or they were no longer cited in the revised narrative text.

A new literature search was conducted in May 2015 and updated in September 2016 to identify additional evidence published since the *ACR Appropriateness Criteria® Urinary Tract Infection—Child* topic was finalized. Using the search strategy described in the literature search companion (see the "Availability of Companion Documents" field), 520 articles were found. Seventeen articles were added to the bibliography. The remaining articles were not used due to either poor study design, the articles were not relevant or generalizable to the topic, the results were unclear, misinterpreted, or biased, or the articles were already cited in the original bibliography.

The author added 5 citations from bibliographies, Web sites, or books that were not found in the new literature search.

See also the American College of Radiology (ACR) Appropriateness Criteria® literature search process document (see the "Availability of Companion Documents" field) for further information.

Number of Source Documents

Of the 91 citations in the original bibliography, 70 were retained in the final document. The new literature search conducted in May 2015 and updated in September 2016 identified 17 articles that were added to the bibliography. The author added 5 citations from bibliographies, Web sites, or books that were not found in the new literature search.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Definitions of Study Quality Categories

Category 1 - The study is well-designed and accounts for common biases.

Category 2 - The study is moderately well-designed and accounts for most common biases.

Category 3 - The study has important study design limitations.

Category 4 - The study or source is not useful as primary evidence. The article may not be a clinical study, the study design is invalid, or conclusions are based on expert consensus.

> The study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
>
> *Or*
>
> The study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
>
> *Or*
>
> The study is an expert opinion or consensus document.

Category M - Meta-analysis studies are not rated for study quality using the study element method because the method is designed to evaluate individual studies only. An "M" for the study quality will indicate that the study quality has not been evaluated for the meta-analysis study.

Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

The topic author assesses the literature then drafts or revises the narrative summarizing the evidence found in the literature. American College of Radiology (ACR) staff drafts an evidence table based on the analysis of the selected literature. These tables rate the study quality for each article included in the narrative.

The expert panel reviews the narrative, evidence table and the supporting literature for each of the topic-variant combinations and assigns an appropriateness rating for each procedure listed in the variant table(s). Each individual panel member assigns a rating based on his/her interpretation of the available evidence.

More information about the evidence table development process can be found in the ACR Appropriateness Criteria® Evidence Table Development document (see the "Availability of Companion Documents" field).

Methods Used to Formulate the Recommendations

Expert Consensus (Delphi)

Description of Methods Used to Formulate the Recommendations

Rating Appropriateness

The American College of Radiology (ACR) Appropriateness Criteria (AC) methodology is based on the RAND Appropriateness Method. The appropriateness ratings for each of the procedures or treatments included in the AC topics are determined using a modified Delphi method. A series of surveys are conducted to elicit each panelist's expert interpretation of the evidence, based on the available data, regarding the appropriateness of an imaging or therapeutic procedure for a specific clinical scenario. The expert panel members review the evidence presented and assess the risks or harms of doing the procedure balanced with the benefits of performing the procedure. The direct or indirect costs of a procedure are not considered as a risk or harm when determining appropriateness. When the evidence for a specific topic and variant is uncertain or incomplete, expert opinion may supplement the available evidence or may be the sole source for assessing the appropriateness.

The appropriateness is represented on an ordinal scale that uses integers from 1 to 9 grouped into three categories: 1, 2, or 3 are in the category "usually not appropriate" where the harms of doing the procedure outweigh the benefits; and 7, 8, or 9 are in the category "usually appropriate" where the benefits of doing a procedure outweigh the harms or risks. The middle category, designated "may be appropriate," is represented by 4, 5, or 6 on the scale. The middle category is when the risks and benefits are equivocal or unclear, the dispersion of the individual ratings from the group median rating is too large (i.e., disagreement), the evidence is contradictory or unclear, or there are special circumstances or subpopulations which could influence the risks or benefits that are embedded in the variant.

The ratings assigned by each panel member are presented in a table displaying the frequency distribution of the ratings without identifying which members provided any particular rating. To determine the panel's recommendation, the rating category that contains the median group rating without disagreement is selected. This may be determined after either the first or second rating round. If there is disagreement after the second rating round, the recommendation is "May be appropriate."

This modified Delphi method enables each panelist to articulate his or her individual interpretations of the evidence or expert opinion without excessive influence from fellow panelists in a simple, standardized, and economical process. For additional information on the ratings process see the Rating Round Information document.

Additional methodology documents, including a more detailed explanation of the complete topic development process and all ACR AC topics can be found on the ACR Web site (see also the "Availability of Companion Documents" field).

Rating Scheme for the Strength of the Recommendations

Not applicable

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

Internal Peer Review

Description of Method of Guideline Validation

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The recommendations are based on analysis of the current medical evidence literature and the application of the RAND/UCLA appropriateness method and expert panel consensus.

Summary of Evidence

Of the 92 references cited in the *ACR Appropriateness Criteria® Urinary Tract Infection—Child* document, 6 are categorized as therapeutic references including 5 well-designed studies and 1 good quality study. Additionally, 80 references are categorized as diagnostic references including 2 well-designed studies, 18 good quality study/studies, and 27 quality study/studies that may have design limitations. There are 33 references that may not be useful as primary evidence. There are 6 references that are meta-analysis studies.

While there are references that report on studies with design limitations, 26 well-designed or good quality studies provide good evidence.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Selection of appropriate imaging procedures for evaluation of pediatric patients with urinary tract infection

Potential Harms

- Renal cortical scintigraphy (RCS) for children is not readily available and usually takes place in specialized medical centers. Studies are performed 3 to 4 hours after intravenous injection and may require sedation in young children. The estimated effective dose of dimercaptosuccinic acid (DMSA) is approximately 1 mSV, which is about 100 times more compared to nuclear cystography and about 10 times more compared to current low-dose X-ray voiding cystourethrography (VCUG) technique.
- Postcontrast computed tomography (CT) scan is sensitive in diagnosing pyelonephritis. However, because of its radiation it should be performed selectively when there is suspicion for complications such as renal abscess or xanthogranulomatous pyelonephritis.
- The potential harms of VCUG relate to exposing children that will not benefit from a prophylactic antibiotic to an unpleasant study associated with minimal ionizing radiation and additional costs. In addition, there was no evidence of a decrease in renal scarring with prophylactic antibiotics, and the proportion of *Escherichia coli* isolates that were resistant to trimethoprim-sulfamethoxazole increased (63% in the prophylaxis group and 19% in the placebo group). Minor adverse drug reactions from prophylactic antibiotics were reported in 7% of children in one trial and antibiotics were stopped for suspected adverse reactions in up to 3.5% of the children in other studies.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document (see the "Availability of Companion Documents" field).

Qualifying Statements

Qualifying Statements

- The American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by

- the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.
- ACR seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply society endorsement of the final document.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

Staying Healthy

IOM Domain

Effectiveness

Identifying Information and Availability

Bibliographic Source(s)

Karmazyn BK, Alazraki AL, Anupindi SA, Dempsey ME, Dillman JR, Dorman SR, Garber MD, Moore SG, Peters CA, Rice HE, Rigsby CK, Safdar NM, Simoneaux SF, Trout AT, Westra SJ, Wootton-Gorges SL, Coley BD, Expert Panel on Pediatric Imaging. ACR Appropriateness CriteriaÂ® urinary tract infectionâ€“child. Reston (VA): American College of Radiology (ACR); 2016. 12 p. [92 references]

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2016

Guideline Developer(s)

American College of Radiology - Medical Specialty Society

Source(s) of Funding

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

Guideline Committee

Committee on Appropriateness Criteria, Expert Panel on Pediatric Imaging

Composition of Group That Authored the Guideline

Panel Members: Boaz K. Karmazyn, MD (*Principal Author and Panel Chair*); Adina L Alazraki, MD; Sudha A. Anupindi, MD; Molly E. Dempsey, MD; Jonathan R. Dillman, MD; Scott R. Dorfman, MD; Matthew D. Garber, MD; Sheila G. Moore, MD; Craig A. Peters, MD; Henry E. Rice, MD; Cynthia K. Rigsby, MD; Nabile M. Safdar, MD, MPH; Stephen F. Simoneaux, MD; Andrew T. Trout, MD; Sjirk J. Westra, MD; Sandra L. Wootton-Gorges, MD; Brian D. Coley, MD (*Specialty Chair*)

Financial Disclosures/Conflicts of Interest

Not stated

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Karmazyn B, Coley BD, Binkovitz LA, Dempsey-Robertson ME, Dillman JR, Dory CE, Garber M, Hayes LL, Keller MS, Meyer JS, Milla SS, Paidas C, Raske ME, Rigsby CK, Strouse PJ, Wootton-Gorges SL, Expert Panel on Pediatric Imaging. ACR Appropriateness Criteria® urinary tract infection - child. [online publication]. Reston (VA): American College of Radiology (ACR); 2012. 8 p. [91 references]

This guideline meets NGC's 2013 (revised) inclusion criteria.

Guideline Availability

Available from the American College of Radiology (ACR) Web site.

Availability of Companion Documents

The following are available:

- ACR Appropriateness Criteria®. Overview. Reston (VA): American College of Radiology; 2015 Oct. 3 p. Available from the American College of Radiology (ACR) Web site.
- ACR Appropriateness Criteria®. Literature search process. Reston (VA): American College of Radiology; 2015 Feb. 1 p. Available from the ACR Web site.
- ACR Appropriateness Criteria®. Evidence table development. Reston (VA): American College of Radiology; 2015 Nov. 5 p. Available from the ACR Web site.
- ACR Appropriateness Criteria®. Topic development process. Reston (VA): American College of Radiology; 2015 Nov. 2 p. Available from the ACR Web site.
- ACR Appropriateness Criteria®. Rating round information. Reston (VA): American College of Radiology; 2015 Apr. 5 p. Available from the ACR Web site.
- ACR Appropriateness Criteria®. Radiation dose assessment introduction. Reston (VA): American College of Radiology; 2016. 4 p. Available from the ACR Web site.
- ACR Appropriateness Criteria®. Manual on contrast media. Reston (VA): American College of Radiology; 2016. 128 p. Available from

the ACR Web site .

- ACR Appropriateness Criteria®. Procedure information. Reston (VA): American College of Radiology; 2016 May. 2 p. Available from the ACR Web site .
- ACR Appropriateness Criteria® urinary tract infection—child. Evidence table. Reston (VA): American College of Radiology; 2016. 32 p. Available from the ACR Web site .
- ACR Appropriateness Criteria® urinary tract infection—child. Literature search. Reston (VA): American College of Radiology; 2016. 2 p. Available from the ACR Web site .

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on May 15, 2007. This summary was updated by ECRI Institute on May 24, 2010. This summary was updated by ECRI Institute on January 13, 2011 following the U.S. Food and Drug Administration (FDA) advisory on gadolinium-based contrast agents. This summary was updated by ECRI Institute on October 12, 2012. This summary was updated by ECRI Institute on January 10, 2017.

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